Space Weather Technical Forecast

Issued on Sunday 13 October 2024 at 13:15 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance G1 Minor Storm day 3 (15 Oct) from possible glancing CME arrival or coronal hole, fast wind onset. Isolated M-class flares likely. Chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low activity with two peak flares of C5.7 at 12/2005 UTC from AR3850 in the southwest, and a second at 13/0657 UTC from AR3848 in the northwest.

There are seven sunspot regions on the visible disc, with the largest of these AR3848 in the northwest. This persists as a large main spot, but with some complexity from an emerging opposite polarity spot to its north. AR3854 and AR3852 just east of the south-centre disc are also of interest. While relatively simple bipolar spots, the interaction between the two of them is potentially the cause of a bright area of magnetic flux visible between these regions in SDO imagery. The other regions remain simple, with the only notable growth being the two new regions just west of the north-centre and another in the northeast.

No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: A disturbed geo-space environment continued as solar winds eased since the 10 Oct CME arrival. Strong solar wind speeds, as observed at L1 by ACE, eased to slightly elevated levels, from just above 600km/s to currently near 450km/s.

Interplanetary magnetic field has been Weak, peaking at 5nT. The north-south component, Bz, was mainly positive (northward) with relatively brief spells of negative (southward) field, ranging +4 to -3nT. Phi angle was neutral and variable for much of the period, but became mainly negative from 12/2030 UTC. Geomagnetic activity was mainly at Quiet to Active (Kp1-4).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was very near background and continued to ease. High energy electron flux (greater than 2MeV) observed by GOES16 was at Background until 12/1110 UTC, then rose to be Moderate with peak 432 pfu at 12/1230 UTC. The associated 24-hour fluence was below the Active threshold with a slight rising trend. The 13/0000UTC observed was 1.1e7 total pfu.

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Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a likelihood of isolated M-class flares and a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There is a chance of a glancing impact from the CME early on day 3 (15 Oct). There are no other Earth-directed CMEs in the forecast. Current disturbed geo-space environment is expected to ease with slightly elevated winds declining to background. There is a slight chance of a fast wind enhancement from CH79/+ day 3 (15 Oct), however this is low confidence. Mainly Quiet to Active geomagnetic activity at first is expected to become mainly Quiet with Unsettled intervals, but with a chance of enhancement from coronal hole or CME effects, mainly on day 3 (15 Oct), with any effects waning day 4 (16 Oct).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES-18 is now largely at background, but there remains a slight chance of further enhancements given any significant flares from AR3848 or potentially the combined AR3852/54. High energy electron flux is expected to continue rising as solar winds ease and the Van Allen belts expand outward again. This brings a chance of High flux, especially before any possible CME arrival or CH fast wind onset day 3 (15 Oct). The associated 24 hour fluence is expected to rise, with a chance of becoming Active (1e8 total pfu), mostly likely days 2-3 (14-15 Oct).

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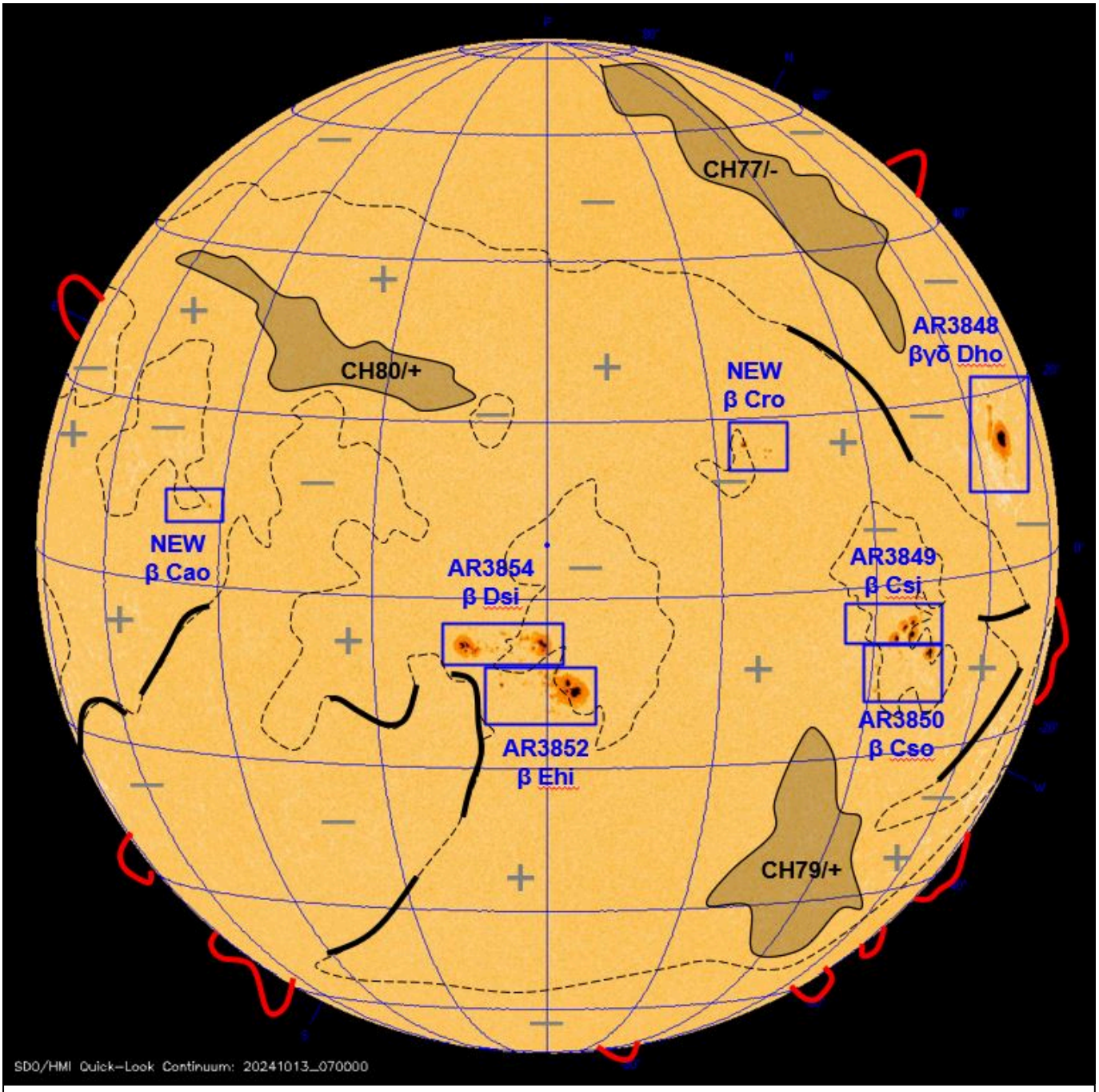
Figure 1: Solar analysis map - valid 13/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There is one potential Earth glancing CME. This originated from an M2.1 from from AR3854 in the east disc, with a glancing impact most likely on day 3 (15 Oct). This is low confidence, due to limited imagery for analysis, and the eastward directed CME, with much of the material passing behind (east of) Earth.

Otherwise, the ongoing slightly elevated solar winds from the CME arrival on 10 Oct are expected to continue gradually easing towards background. There is a potential coronal hole fast wind onset from CH79/+ which is in the southern disc. This was present on the previous rotation, albeit slightly different in shape, and showed no notable enhancement. Confidence is Low, however, as MOSWOC Enlil is providing little guidance, as this is over-estimating the extent of a non-existent broad fast wind from the southern disc, likely due to current limitations with GONG H-alpha imagery that initialises the model. Overall there is a slight chance for a connection to this southern coronal hole, most likely on day 3 (15 Oct).

Quiet to Active conditions are expected to become mainly Quiet with isolated Unsettled intervals later day 1 (13 Oct) as solar winds continue to ease. Although a very slight chance of G1 Minor storm is maintained at first due the potential for any sub-storming effects. This continuing through the period, but with a chance of a spell of Active to G1 Minor Storm from any CME arrival on day 3 (15 Oct). There is also a slight chance of more prolonged fast wind enhancement from CH79/+, also on day 3 (15 Oct), which could also bring Active to G1 Minor Storms.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	30	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
12/0102	Nil	AR3854	27E 01S	480	Early 15 Oct	Low confidence. Glancing impact at most.

Figure 2: Enlil, showing slight enhancement from CME arrival. Low confidence, with Enlil over-estimating the strength of the solar wind to the south.

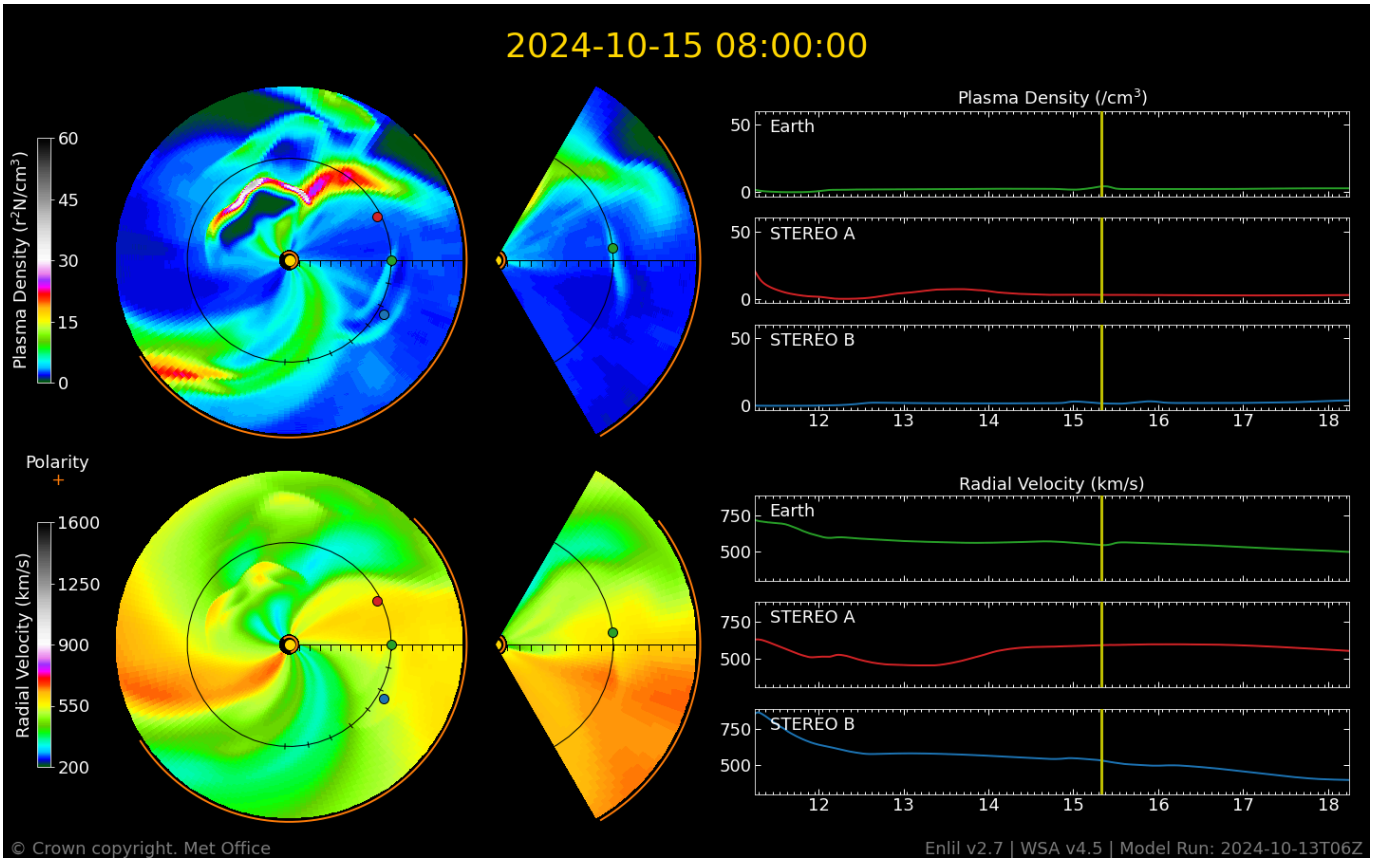

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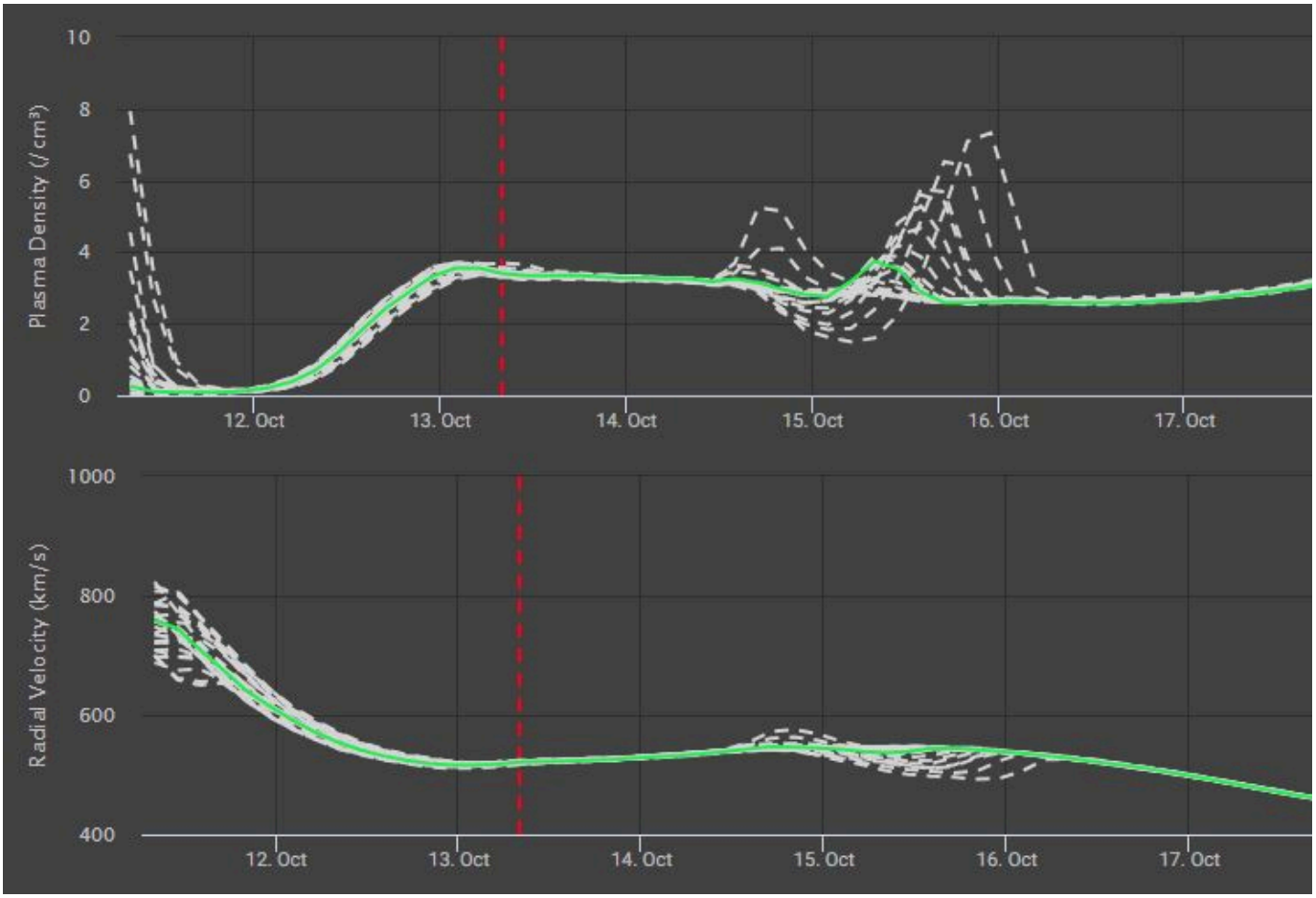
Figure 3: Enlil' Ensemble also shows the possibility of a glancing blow CME on the 15 Oct. A few members suggest a slightly later arrival, early on the 16 Oct. Low confidence.



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Radio Blackouts - X-Ray Flares

Low to Moderate activity is expected to continue with a likelihood of isolated M-class flares and a slight chance of X-class flares. These most likely from AR3848, or perhaps from the combination of AR3852 and AR3854.

There are seven sunspot regions currently on the Earth-facing disc. The largest of these is AR3848, the source of an X1.8 early on 9 Oct, but otherwise has been largely inactive. However, this persists as a region with strong magnetic flux, dominated by a large positive leader spot, with small negative polarity trailers to its north and south. The northern trailers currently appear to share penumbra with a small northward extension from the main positive spot, resulting in a weak and tenuous delta spot configuration, although this may be separating and weakening. This region is becoming harder to assess however, as it is now approaching the northwest limb.

Elsewhere AR3852 and AR3854 form a cluster of two regions, just east of the south-centre disc. Despite being relatively simple bipolar groups, these have shown some limited growth in areal extent and are showing some magnetic interaction with the brightening of a flux rope between them in SDO imagery, likely due to the proximity of the positive intermediate spots of AR3852 and the leader of AR3854. AR3850 and AR3849 also form a close proximity cluster of regions in the southwest, but are smaller and simpler regions, primarily comprised as a cluster of negative spots, with much smaller positive trailers that have remained less persistent and often more pore like. The other two regions are newly developing regions, with one just west of the north-centre disc, and the other in the northeast.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	No	70	70	60	60
Very Active	**R3-R5 (X Class)**	No	15	15	10	10

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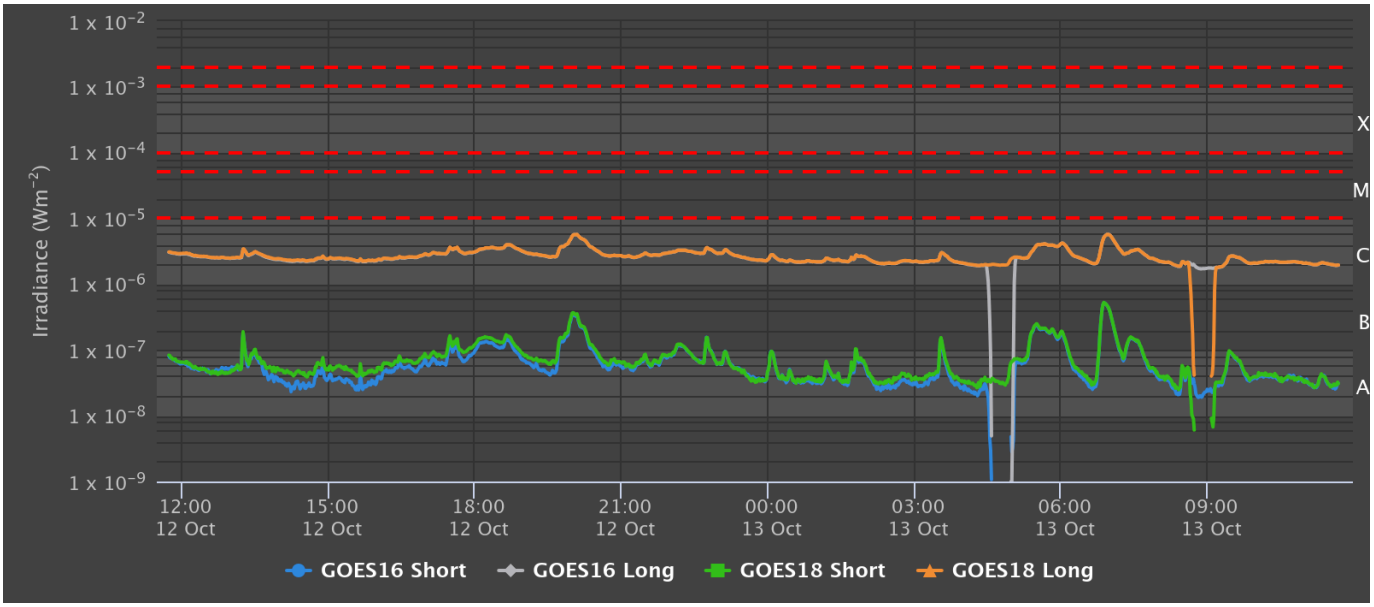
Figure 4: GOES-16/18 X-ray flux.



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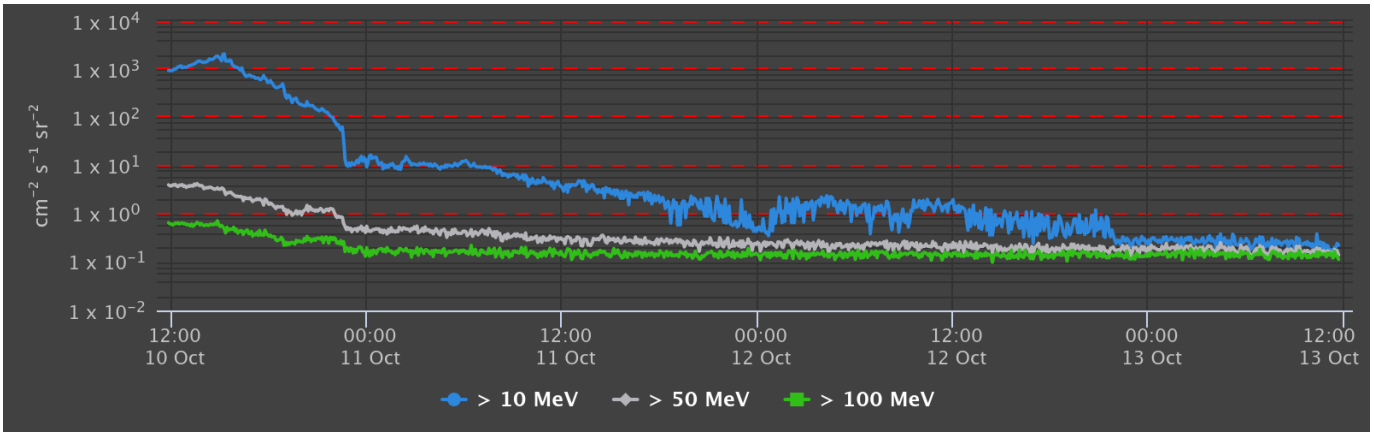
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is expected to remain at background, but maintains a chance of further enhancement given any further notable flares, primarily from AR3848, but also possible from any AR3852/54 combined flare, and cant be completely ruled out on day 1 (13 Oct) from over the limb from ex-AR3847 as it retreats onto the far side, however this is looking increasingly unlikely at this stage.

Any enhancement will bring a slight chance of reaching the S1 Minor Radiation Storm threshold.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES 16 Proton Flux for the past 3-days (Greater than 10MeV, 50MeV and 100MeV)



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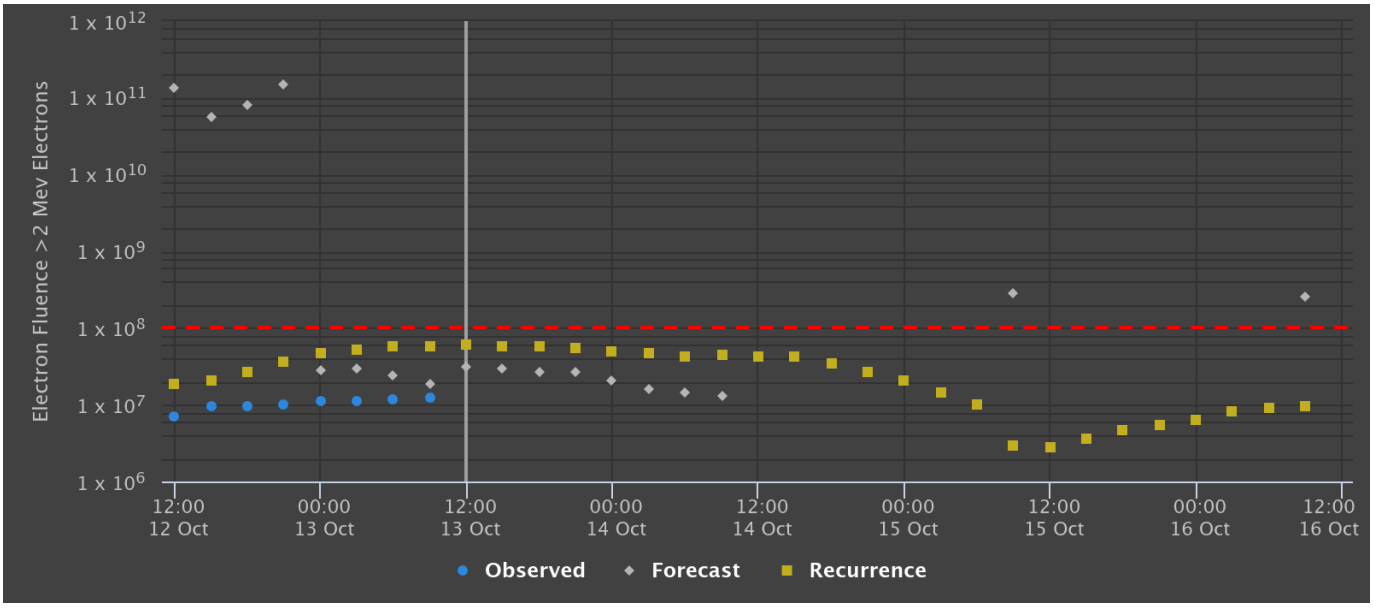
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES-16 is currently at Background to Moderate. The recent CME arrival and subsequent strong solar winds has likely increased counts at lower orbits, with the Van Allen belts compressed inward by the ongoing solar wind pressure. As solar winds ease, flux is expected to rise at GEO to become Moderate to High with a chance of becoming persistent High by day 2 onward (14 Oct). However, this is low confidence, and confidence is further lowered by the potential glancing CME arrival on day 3 (15 Oct). Any such arrival is likely to drop out the flux at GEO to background again, with any subsequent enhancement low confidence

The associated electron fluence is expected to be below the Active level (1e8 total pfu), but with a rising trend. This will bring a chance of Active fluence, most likely day 2-3 (14-15 Oct) before the subsequent CME arrival reducing the potential for Active fluence. REFM is currently over-estimating the observed fluence, however this does show the potential for an increasing trend, once the solar wind pressure does ease.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	10	25	25	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: REFM electron fluence, which shows a likely rising trend.



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